

LENTINUS LEPIDEUS FR.: A CAUSE OF HEART ROT OF LIVING PINES

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The scaly *Lentinus*, *Lentinus lepideus* Fr., is well-known as a saprophyte, decaying coniferous stumps, logs, foundation timbers, ties, etc., over a wide range in the North Temperate Zone.

As a heart rot of living trees it appears to be much less familiar. Hedgcock (3) in 1912 reported it or a closely related form as attacking the heartwood of both living and dead conifers in the National Forests but, owing to the scope of the paper, no details of his observations were included. Meinecke (6), in speaking of the sporophores of the fungus found on the butts of *Pinus jeffreyi* A. Murr., *P. ponderosa* Doug., and *P. contorta* Doug. in California, stated that occasionally they grew "on the dead roots of living trees and also high up on the trunk." A species of *Lentinus* parasitic on the roots of conifers in the western United States has been mentioned by Weir (8). He regarded it as a probably undescribed species but has verbally informed the writer that the fungus to which he referred is the one commonly known as *Lentinus lepideus* in the West. More recently, Martin (5, p. 407) observed sporophores of the fungus growing from branch scars on a living pine in Washington, D. C. While the occurrence of *Lentinus lepideus* or closely related forms in connection with living trees has thus been reported for some time, the fact seems not to have gained general attention and is not referred to in our pathological texts.

The situation is no doubt due in part to the uncertainty, as voiced by Hedgcock and Weir, regarding the true identity of the western fungus. While there appears to be some difference between the western form and the common one of the eastern United States and Europe, yet, as Harper (2) has pointed out, the species is everywhere quite variable and it is questionable whether the western fungus is any more entitled to specific rank than any one of the morphological variations found elsewhere. In the present paper common custom will be followed in referring to the fungus simply as *Lentinus lepideus* without entering the question as to the correctness of such usage.

The original report by Hedgcock was based mainly on field notes and collections made by him in connection with the Timber and Forest Disease Survey conducted for the United States Department of Agriculture some years ago. The fungus was noted at several places in the Western and Middle-western States with living *Pinus ponderosa*, *P. contorta*, and *P. banksiana* Lamb. as hosts. In some instances sporophores were found con-

nected with a brown heart rot within the tree, from which the fruiting bodies issued through knotholes or open wounds. In general he found that the rot appeared to be confined to the heartwood but in one lodgepole pine (*P. contorta*) the sapwood adjacent to a basal fire scar was also involved.

Collection and field notes in the files of the San Francisco Office of Forest Pathology contain a number of records of the fungus observed on living western yellow pine (*P. ponderosa*) and lodgepole pine by Meinecke. Sporophores were noted growing from the bases of trees, from roots near the base or directly from decayed heartwood through openings in the trunks.

FIELD OBSERVATIONS ON INDIVIDUAL CASES IN CALIFORNIA

Within the past few years additional finds of the fungus have been made in California on living western yellow pine and on sugar pine (*P. lambertiana* Doug.), a previously unrecorded host. Several of these cases were

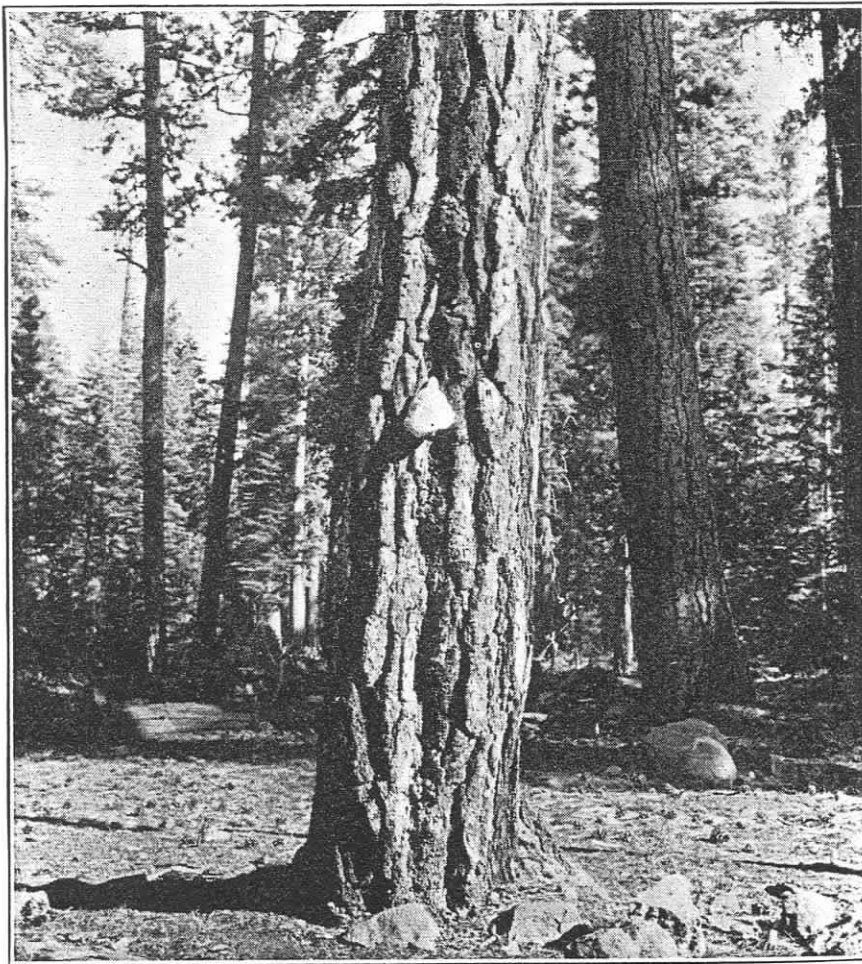


FIG. 1. Sporophore of *Lentinus lepideus* growing from an old, bark-closed wound on *Pinus ponderosa*, Westwood, California.

encountered in the course of a study of decay carried out under the direction of Dr. E. P. Meinecke in connection with the logging of a government timber sale in the central Sierra Nevada Mountains. The stand was of mixed conifers of large size, mostly mature, growing at an elevation of 5000 feet.

The first case noted occurred in a western yellow pine measuring 56 inches in diameter breast high and originally 180 feet tall. At the time of felling, early in September, only a standing snag 70 feet in height remained, the entire top having broken out during a severe windstorm the previous fall. The diameter of the bole at the break was about 28 inches. Western yellow pine is ordinarily very resistant to breakage of this sort and the fact that no similar damage was shown by adjacent trees pointed to some weakness of the bole in the region of the break.

The tree was examined about four weeks after felling. A dry, mature sporophore of *Lentinus lepideus* about 15 cm. in diameter was found projecting from a recess in the decayed wood on the top end of the snag. It arose from a felty, mycelial pad formed over the surface of the wood and was of the normal pileate type. Its shape and condition indicated that the sporophore had matured and hardened on top of the snag before felling.

The lower end of the long broken-off top which had lain on the ground over winter bore a sterile fructification consisting of a curving, branched, compound stipe with brown, conically pointed tips. It arose from a mycelial pad similar to that at the base of the normal sporophore, except for soil and litter embodied in the surface. The production of sterile fructifications of this type is known to be a common phenomenon for *Lentinus lepideus*. The shapes are frequently grotesque (7, p. 411). Experiments by Buller (1) showed that light has a strong influence in determining the form of the fruiting body. In the present case the normal sporophore developed in full sunlight while the end of the break bearing the abortive one, lay so that it was constantly, though not heavily, shaded. In view of Buller's experiments, this may account for the dissimilar development of the two fruiting bodies. Normal pileate sporophores were later produced from both portions of the down tree.

Decay and discoloration in connection with the sporophores extended roughly spindle-shape for 12 feet above and 8 feet below the break, or a total distance of 20 feet along the bole in both heartwood and sapwood. The rest of the tree was sound. The decay centered around a long, narrow wound, dating from 1895, on the side of the bole and probably due to a falling tree or snag. This wound quite evidently served as the entrance point for the fungus, its subsequent development weakening the bole so that it was unable to withstand the stress of the heavy wind.

An important factor in the weakening was the death of the callus-tissue and sapwood for about a foot on each side of the wound after normal callus formation had continued for a number of years. The dead area was found to be in various stages of decay from *Lentinus* and was covered for the greater part by a creamy-white mycelial felt about 1/16 of an inch thick, which had formed between the wood and the overlying bark. No definite cause could be ascribed for the death of this zone of sapwood. However, the presence of the fungus apparently throughout the decayed area and the absence of indications of any other cause for death suggested its possible connection with the killing.

The rot itself was not pronounced except in the vicinity of the wound where, for a depth of about 6 inches, the wood had disintegrated into long, rectangular, brown flakes or chunks of carbonaceous texture. The rest of the affected wood appeared solid in cross section, but, when tested with the point of a knife blade, proved to be softer than normal and lacking in elasticity. Thin mycelial felts showed in longitudinal section but were confined to the small shrinkage checks near the surface of the break. The color of the wood was a slightly darker yellow than normal, shading into a reddish tinge in places. The sporophores did not develop from the badly disintegrated outer wood but from the more solid heartwood about 10 inches in from the outside of the trunk.

A loss of 3000 board feet resulted from the decay and the breakage caused by it in this tree.

A second case of the rot was disclosed by the felling of a living yellow pine 40 inches in diameter and 188 years of age at stump height. The entire heartwood at the stump was involved in a spongy, reddish brown decay with a resinous, aromatic odor suggesting *Lentinus lepideus*. A cluster of two sporophores and an abortive stipe of the fungus were found hidden under a layer of needles and dry duff about 2 feet from the base of the tree. They arose from a shallow, decayed root about an inch in diameter. The decay appeared to connect through this root with that in the butt of the tree though conditions prevented excavation to determine this point definitely. Some support was afforded by the fact that agar cultures of the decayed wood from the stump gave typical *Lentinus lepideus* growths. The rot was confined to the butt of the tree, resulting in a deduction for cull of 140 board feet in the scale of the first log. Infection had presumably taken place through a fire scar, open since about 1850, at the base of the tree.

A third case of the disease was found in the upper bole of a sugar pine 67 inches in diameter breast high. The tree had been broken off at 133 feet from the ground, resulting in the loss of much of the crown but leaving a number of large live limbs just below the break. The diameter at the break

was about 14 inches, but it increased rapidly below this point. Decay extended down in the heartwood of the trunk for 11.5 feet, attaining a maximum diameter of 20 inches. It also entered the bases of several of the live branches. The center for some distance down had become hollow, and attached to the decay on the sides of the hollow were a number of stained and misshapen fruit bodies, mostly abortive, and some so covered with bits of decayed wood and débris as to be scarcely recognizable. One or two had developed sufficiently to be identified as *Lentinus lepideus*. The length of time the fungus had been present could not be determined. A cull loss of about 100 board feet resulted.

Several additional living yellow pines affected with the decay have since been noted by the writer. In one of 45 inches diameter, found later on the same sale area, the fungus had entered through an old broken top and had destroyed the heartwood for 40 feet below, resulting in a cull loss of 1060 board feet. The decayed portion of the bole split its entire length when the tree was felled.

Another tree, 48 inches in diameter, on which a *Lentinus* sporophore had been seen issuing from an exposed root, was examined. Some years before, a road had been excavated on the slope immediately below this tree, resulting in the soil and a number of large roots being cut away on the lower side. Other roots were partly exposed. Due to the location it was impossible to fell the tree for examination but ax cuts and soundings showed the base to be badly decayed for at least 8 feet above ground. On the side next to the road the sapwood was dead and had decayed until only a thin shell of firmer dry wood remained on the surface.

About a month intervened between the time the sporophore was noted and the time the examination was made. In the meantime the fruiting body had been removed by man or animal so completely that not even its point of attachment could be definitely determined.

The root from which it was thought to have issued was about 4 inches in diameter and was virtually exposed for about a foot of its length, beginning three feet out from the tree. A cut made through at the middle of the exposed length showed nearly two-thirds of the cross section decayed. The rest was still alive. The root was next excavated back to its junction with the base of the tree and opened up. It was seen that the decay continued back and connected with the main body of rot in the base of the trunk.

In order to make certain that the decay in the root and that in the trunk were identical, agar cultures were made of each. The growths obtained agreed in all particulars with each other and with authentic cultures of the fungus. This case supports previous indications that the decay may extend into the roots of a tree while the latter is still alive.

THE DECAY

Early stages of the decay in living pines have no very marked characteristics. The wood becomes brash and darkens slightly in color, with a faint reddish tinge appearing in some cases. Little or no shrinkage in excess of that in the normal wood takes place. Thin mycelial felts are formed in checks or shakes, particularly in portions from which sporophores will later develop.

In later stages the decayed wood is friable, crushing to a powder when rolled between the thumb and finger, but with a cheesy or sticky character when fresh due to contained moisture and to infiltration of oleoresins. These latter the fungus appears to be able to liberate in unusual degree. The infiltration is particularly noticeable in decay in the butts of trees or in the vicinity of fire scars or wounds and causes the decay to appear darker in color than when dried out.

The essential oils volatilize rather rapidly from freshly-exposed decay, giving it a highly aromatic, resinous odor, noticeable at some feet distant. A fragment no larger than one's little finger will, when freshly broken, sometimes scent an entire room. Coupled with the resinous odor is one of a fungous nature, the combination making an odor peculiar, so far as the writer knows, to the decay of *Lentinus lepideus* and readily recognized, once one has become acquainted with it.

Some shrinkage cracks form in fresh decay of the later stages but, as a rule, it is not until the decay has been exposed and subjected to drying that it breaks up into the brittle, cubical chunks typical of the carbonizing rots. In *Lentinus lepideus* the chunks are rather large and rectangular, corresponding in size to those of *Fomes laricis* (Jacq.) Murr. except in sapwood where smaller cubes are formed. A variation sometimes found in decayed heartwood is the breaking up into thin rectangular flakes, the wood separating tangentially along the annual rings. This is brought about by the greater resistance of the summerwood to the action of the fungus and is more likely to be found in intermediate stages of the decay. In color, dry decay varies from cinnamon buff and clay to cinnamon and sayal brown, weathering on exposure to a dark brown or grayish brown. Thin, tough felts of mycelium are ordinarily present.

The dry decay sometimes resembles that of *Fomes laricis* so closely that specimens of each placed side by side can not be told apart visually though a distinction can easily be made on the basis of odor. The microscopic characters of the two decays are very similar (4). Old weathered decay is almost indistinguishable from that of *Polyporus schweinitzii* Fr. In a fresh state the decay, because of its odor, absence of checking into cubical form, and its consistency, can scarcely be confused with either of the others mentioned.

As indicated by the field cases reported, the rot is not characteristically limited to any particular portion of the bole. However, owing to the concentration around the base of the tree of wounds favorable to its entrance, infections of the fungus are more likely to be found in the heartwood of the butt.

HOSTS AND DISTRIBUTION

A summary from records at hand shows the following distribution for observed cases of the fungus on living trees:

| | | | | |
|------------|----|------------------------|---|-------------|
| California | on | <i>Pinus ponderosa</i> | 7 | localities. |
| " | " | <i>contorta</i> | 2 | " |
| " | " | <i>lambertiana</i> | 1 | locality. |
| Arizona | " | <i>ponderosa</i> | 1 | " |
| Montana | " | <i>contorta</i> | 1 | " |
| Minnesota | " | <i>banksiana</i> | 1 | " |
| Dist. of | | | | |
| Columbia | " | sp. | 1 | " |

For several of the Californian localities and also for the one in Arizona more than one case of the rot has been found.

These distributional records and supporting field observations indicate that decay from *Lentinus lepideus* in living pines is not uncommon in the west Sierran region of California but to be found only occasionally or rarely elsewhere in the country. The Californian localities are well distributed over the west slope of the Sierra Nevada range.

The reasons for the apparent greater prevalence in California are not entirely clear. It may be noted in this connection however that the fungus is an extremely common saprophyte on stumps and down logs in the region and that the yellow-pine stands have a heavy representation of large, mature trees, most of which bear fire scars or wounds of some sort.

SUMMARY

Lentinus lepideus, well-known as a saprophyte, also causes a heart rot of living pines, particularly of the western yellow pine, *P. ponderosa*. It also has been found in *Pinus contorta*, *P. lambertiana*, and *P. banksiana*.

The fungus enters through wounds and may attack any part of the heartwood of the bole or extend into the roots. In rare cases the sapwood is also affected.

A friable decay, often characterized by an infiltration of oleoresins, is caused. The dry decay resembles that of *Fomes laricis* but may be distinguished by the resinous, fungous odor.

Field observations and collection records indicate that the decay is fairly common in living pines in the forests of the Sierra Nevada in California and rare elsewhere in the United States.

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